Clouds 2

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Flow Visualization – MCEN 4151
Professor Hertzberg
4/19/2012

Purpose

The purpose for this cloud flow visualization was for the "Clouds 2" assignment assigned in the Flow Visualization course given at the University of Colorado at Boulder, led by Professor Hertzberg. The goal of the "Clouds 2" assignment was to display the physics of clouds in both an experimental and artistic way. It was my intent to display the unique stratocumulus cloud often seen in Boulder during the Spring time.

Location

In my final image, I chose to photograph the clouds from the grass field located in between the Leeds School of Business building and the Engineering Center located just west of the Coors Event Center in Boulder, CO on April 11th, 2012 at 12:08 pm. My exact location during the shot was at 40 deg 0' 14.399" N latitude, 105 deg 16' 3.000" W longitude, with an elevation of 1675 meters (all given in the picture's metadata). I pointed my camera directly upwards at the sky, and photographed the clouds at roughly a 90 degree angle from horizontal.

Environment

There are three different types of clouds that can be identified in the photograph. First, the large cloud in the image is known as a stratocumulus cloud. These clouds are prominent during late-Winter and early-Spring time in Colorado. Stratocumulus clouds belong to a class of clouds known for being large, dark, and rounded, and usually travel in groups, lines, or waves.[1] These clouds typically occur below 2,400 m (8,000 ft)[1]. Stratocumulus clouds remain at this elevation due to convective currents creating shallow cloud layers due to drier and more stable air preventing the cloud from climbing in elevation[1]. Stratocumuli have been known to carry precipitation on occasion, but the resulting weather is usually not intense. They will however indicate an incoming storm. Second, it is evident that there are cases of cumulus fractus in the image. Cumulus fractus clouds appear like ragged cumulus clouds. They tend to originate from dissipated cumulus clouds[2]. Third, while it's hard to view cases in the photo in which cumulus fractus gather closer with one another, this type of behavior was occurring outside of the frame of the photo. When this situation occurs, the clouds become classified as cumulus humilis clouds. Cumulus humilis clouds typically occur at low to middle altitudes that are commonly referred to as the "fair weather cumulus" clouds[3]. Over mountainous terrain such as Boulder's Flatirons, these typically occur at up to 6,000 meters in altitude[3] but often occur below that. The cumulus humilis cloud forms through the process of warm air rising that has been heated from the ground[3].

When I took the image, the sky appeared to be very stable, and when looking at the Weather Underground iPhone application, the application confirmed this assumption. The sky was seen as a dark, slate blue color with a grey tone (as seen in the original). The weather for the day can be seen below:

4/11/12 11:55p		Last 24 hours		
	Current	Minimum	Maximum	Average
Temperature (F)	51.0	46.3 @ 06:40	69.8 @ 15:05	57.0
Dewpoint (F)	41.9	35.7 @ 06:30	49.3 @ 22:30	44.0
Humidity (%)	71	41 @ 15:05	82 @ 22:40	63
Solar Flux (W/m^2)	0	0 @ 00:05	923 @ 12:15	196
Pressure (mb)	825.1	823.7 @ 23:40	833.7 @ 07:25	830.5
Wind Speed (mph)	6.0	0.0 @ 00:20	14.0 @ 22:55	2.3
Peak Gust Speed (mph)	14.0	0.0 @ 19:50	29.0 @ 23:00	5.9
Wind Direction (deg)	248			
Rainfall today (inch)	0.14			

Figures 1&2: Weather Underground (Left)[4]; CU ATOC Weather Network (Right)[5]

Further information can be seen below for the weather behavior throughout the entire day:

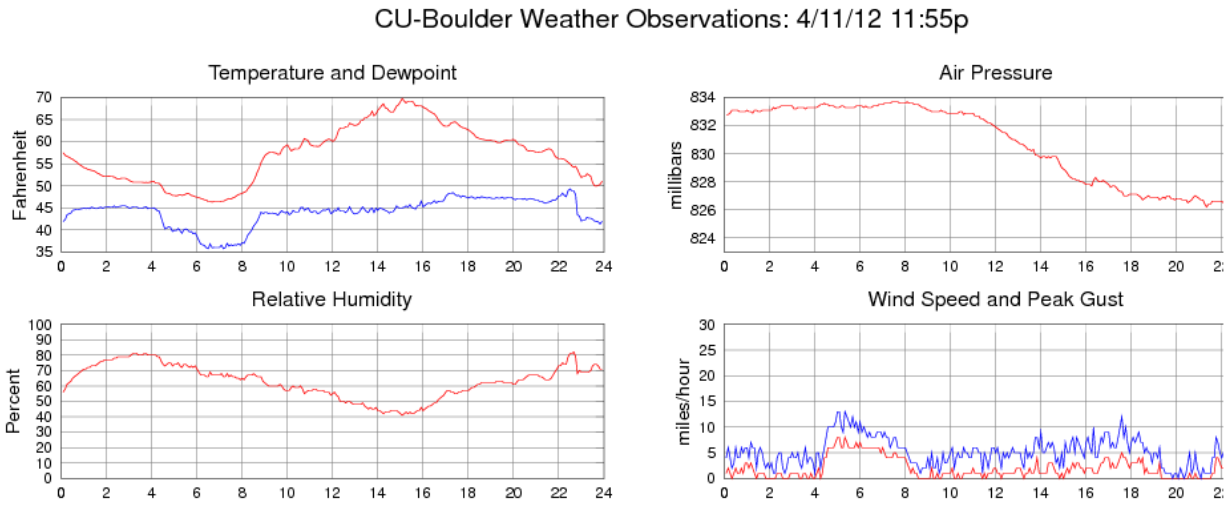
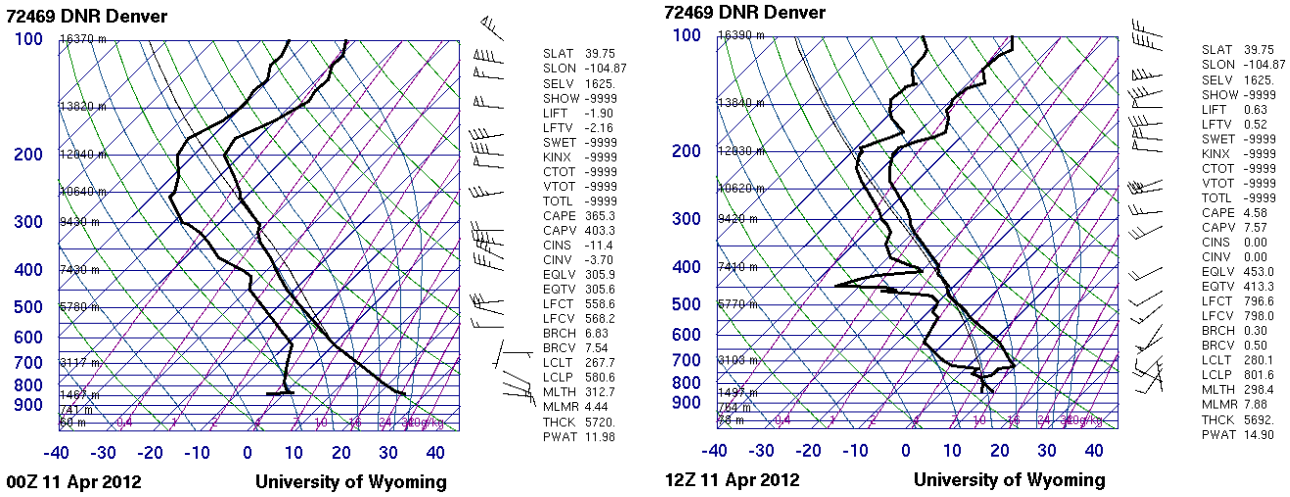


Figure 3: Weather Observations Graphs[5]

The skew-T plots can be seen below:



Figures 4&5: 00Z 11 Apr 2012 (Left)[6]; 12Z 11 April 2012 (Right)[6]

I chose to include both skew-T plots in this write-up since my picture falls in between both plots.

At 12:08 pm, it was roughly 61 degrees Fahrenheit with no wind whatsoever (Figure 1). Precipitation had commenced approximately 4 hours after taking the picture (≈ 4 pm), and later into the night it rained heavily. The day previous, April 10th, exhibited no precipitation, but had a mean temperature of 58.4 degrees Farenheit[7] and very little clouds, while the 12th exhibited a mean temperature of 51.4 degrees Farenheit[8]. Through this three-day window, it can be seen that the temperature varied slightly, with a peak change occurring in between the 11th and 12th. The clouds did show signs of a front coming in, with elevated humidity, and tiny bits of precipitation sprinkled throughout the day (typical of a stratocumulus cloud).

The skew-T plots shown in Figures 4 and 5 do not display the weather behavior at the time I took the photo, since the 00Z skew-T correlates with early morning weather, and the 12Z correlates with late afternoon weather. Both of the skew-T plots don't properly demonstrate the weather patterns that were occurring the moment I took the picture, but in performing research on the clouds and having the picture critiqued in class, these clouds do fall under the stratocumulus, cumulus fractus, and cumulus humilis cloud families. Figure 6 below shows the calculation of the cloud's altitude and temperature at the time I took the photo:

Unit	Number
Required Data Entry	
Choose Temperature	Degrees F Designation
Choose Distance	Meters Designation
Air Temperature (A)	61 Degrees
Dew Point (D)	45 Degrees
Calculated Results	
Approximate Cloud Altitude	1108.3 Selected Units
Approximate Cloud Temperature	41.4 Degrees

Figure 6: Calculation of Cloud's Altitude and Temperature[9]

As seen from Figures 4, 5, and 6, the clouds photographed have an approximate altitude in the range of 1,000 – 1,500 meters. When taking the picture, I noticed that the clouds were much lower in elevation than the common altocumulus lenticularis clouds often seen in the Boulder area. I took the picture without using a zoom function, displaying how close the clouds truly were.

Photograph Technique

For this experiment, I chose to use my iPhone 4 camera. I did this because I didn't have my Fujifilm J20 with me at the time, but wanted to capture the current low-floating clouds which I hadn't seen very often. I shot the picture with no flash, no zoom, and used the HDR feature on the iPhone to capture the cloud flow. The field of view for the finished photograph was roughly 2-3 miles in height by 2-3 miles in width. The distance from the field surface to the clouds was approximately 725 meters. The dimensions for the original photo are 2592 pixels in width by 1936 pixels in height, and for the finished photo are 2300 pixels in width by 1932 pixels in height. The horizontal and vertical resolution was 72 dpi. The aperture was 2.8, with an exposure time of 1/10,000 of a second, ISO of 100, and a focal length of 4 mm. I used the GIMP 2 software to perform editing on the image. I used a tutorial on YouTube explaining how to make your images appear as if they were shot as a HDR image[10]. This tutorial had me download a patch for GIMP 2 known as Dodge and Burn[11]. I performed the steps according to how the tutorial described, and played around with the curves to show the definition within the clouds. I

cropped out the tree limbs from the original photo to prevent any type of distraction from occurring.

Conclusion

It was my goal of this assignment to demonstrate the flow of the stratocumulus cloud that occurs in Boulder, CO. I believe that I achieved my goal, and have been able to demonstrate these great clouds scientifically while also being artistic. I really enjoy the new editing method that I discovered within GIMP and I continue to use it on every picture that I take from now on. I really liked seeing the blues come out in the image, and the definition and texture within the clouds. In the future, I'd like to use a nicer camera to capture these clouds in hope of obtaining a more crisp and clean image, detailing more of its flow design. This assignment has definitely made me more aware of weather systems occurring currently and what could happen in the future. I'll never look at the sky the same way again after this experience.

Original Photo

References

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Image Assessment Form

Flow Visualization

Spring 2010

Name(s): Ryan Kelly

Assignment: Clouds 2 Date: 4/19/2012

Scale: +, ! = excellent √ = meets expectations; good. ~ = Ok, could be better. X = needs work. NA = not applicable

Art	Your assessment	Comments
Intent was realized	!	
Effective	!	
Impact	!	
Interesting	!	
Beautiful	!	
Dramatic	!	
Feel/texture	!	
No distracting elements	!	
Framing/cropping enhances image	!	

Flow	Your assessment	Comments
Clearly illustrates phenomena	!	
Flow is understandable	!	
Physics revealed	!	
Details visible	!	
Flow is reproducible	!	
Flow is controlled	NA	
Creative flow or technique	!	
Publishable quality	√	Could shoot with better camera

Photographic technique	Your assessment	Comments
Exposure: highlights detailed	!	
Exposure: shadows detailed	!	
Full contrast range	!	
Focus	!	
Depth of field	!	
Time resolved	!	
Spatially resolved	!	
Clean, no spots	!	

Report		Your assessment	Comments
Describes intent	Artistic	!	
	Scientific	!	
Describes fluid phenomena		!	
Estimates appropriate scales	Reynolds number etc.	!	
Calculation of time resolution etc.	How far did flow move during exposure?	!	
References:	Web level	!	
	Refereed journal level	X	No refereed journal
Clearly written		!	
Information is organized		!	
Good spelling and grammar		!	
Professional language (publishable)		!	
Provides information needed for reproducing flow	Fluid data, flow rates	!	
	geometry	!	
	timing	!	
Provides information needed for reproducing vis technique	Method	!	
	dilution	!	
	injection speed	!	
	settings	!	
lighting type	(strobe/tungsten, watts, number)	!	
	light position, distance	!	
Provides information for reproducing image	Camera type and model	!	
	Camera-subject distance	!	
	Field of view	!	
	Focal length	!	
	aperture	!	
	shutter speed	!	
	film type and speed or ISO setting	!	
	# pixels (width X ht)	!	
	Photoshop techniques	!	
	Print details	!	
	"before" Photoshop image	!	